ORIGINAL ARTICLE

ANALYSIS OF "BEST FIT" OF COMMERCIALLY AVAILABLE ARCHWIRES WITH MANDIBULAR ARCH FORM

[1]AMJAD MAHMOOD, [2]NAZISH AMJAD, [3]RAI TARIQ MASOOD, [4]ROZINA NAZIR

ABSTRACT

Aim of the present study was to analyse which archwire fits best to the mandibular arch form among different commercially available archwires. This cross-sectional study was conducted in Orthodontic department of Margalla Institute of Health Sciences (MIHS) Rawalpindi from March 2017 to October 2017.

The study included pre-treatment mandibular casts of 100 patients (72 females, 28 males) with mean age of 15±1.8 years, having permanent dentition at least up to 2nd molars. Seven types of preformed heavy stainless steel archwires from 3 different manufacturers were scanned and archwire templates were made on transparency sheet. These archwire templates were then placed over mandibular casts. Archwire that corresponded to the patient's mandibular arch form more closely and touched the maximum number of teeth was termed as best fit.

Preformed archwires that corresponded to mandibular arch form more closely were Ortho Organizers Oval Arch Form (34%) and Standard Form (27%). 3M Unitek Ortho Form I (tapered) was found best fit in 15% of the patients. Archwire having lowest frequency (2%) as best fit was 3M Unitek Ortho Form II (square).

It was concluded that among different commercially available archwires in Pakistan, Ortho Organizers archwires (Oval Arch Form and Standard Form) were found best fit to the mandibular arch form in majority of the patients.

Key Words: Mandibular arch form, Archwire, mandibular arch form

INTRODUCTION

Archwires are the essential and active components of fixed orthodontic treatment.[1,2] They store and deliver force to the teeth and surrounding tissues through the brackets and bands. Use of improperly shaped archwires results in several complications during treatment and increased chances of relapse.[3,4] Instability results from un-planned expansion or constriction, especially in the canine and molar regions.[1,5-8]

Square, ovoid and tapered are the three main categories of dental arch form.[4] In order to achieve an aesthetically pleasant and functionally stable orthodontic treatment results, it is fundamental to correctly identify and maintain the patient pre-treatment arch form.[2,4] According to long-term studies on retention, alteration to the arch form results in more post-treatment changes as compared to when the arch form is maintained.[6,9] Evidence suggests that one of the most definitive ways of increasing post-treatment stability is by the maintenance of the pre-treatment arch form where the teeth are meant to be in their stable position.[10-12]

Mandibular inter-canine and inter-molar widths are precise indicators of innate muscle balance of every individual and they also determine the extent of arch expansion during orthodontic treatment.[1] Lee[13] and Bishara et al[14] have both acknowledged that changes in the arch shape can result in instability, damage of the periodontium and relapse, especially when there is an increase in the mandibular inter-canine width.

The use of prefabricated superelastic archwires across the globe makes it critically important that assessment of precise arch form for different races/ethnic groups should be done. Ethnicity is a crucial factor that affects the shape and dimension of dental arch forms. Cephalometric and anthropometric studies of facial and cranial measurements suggested that there are profound differences among different ethnic groups.[2] Indeed, Caucasians have deeper and narrower arches

[1] Dr Amjad Mahmood, BDS, FDS RCSEd (Orthodontics), Professor and Head of Department Orthodontics, Margalla Institute of Health Sciences, Rawalpindi

[2] Dr Nazish Amjad, BDS, FCPS (Orthodontics), Senior lecturer Department of Orthodontics, Dental College HITEC-IMS, Taxila **For Correspondence:** House 275, Street 55, Sector F11/4, Islamabad, Pakistan Cell: 0334-4203033 Email: nazishamjad86@gmail.com

[3] Rai Tariq Masood, BDS, MSc (UK), Associate Professor and Head of Department Community dentistry, Rawal Institute of Health Sciences, Islamabad

[4] Dr Rozina Nazir, BDS, FCPS (Orthodontics), Professor and Head of Department Orthodontics, Foundation University College of Dentistry, Rawalpindi

Received for Publication: April 15, 2019
Revised: June 25, 2019
Approved: June 29, 2019

than those of the Japanese.[15] Arch forms of Egyptians are narrower as compared to that of American whites[2].

During levelling and alignment stages, orthodontists frequently use superelastic NiTi archwires to apply lighter forces. These archwires are prefabricated and their adaptation and bending is not possible. Therefore proper arch form selection according to patient's dental arch form is more critical for NiTi archwires as compared to stainless steel archwires because they are bendable and formable. Every patient has his/her own unique arch form and if appropriate shaped archwire is not selected it may result in unnatural smile and/or relapse.[2] As a result, it is essential that before the orthodontic treatment commences, archwire is selected that corresponds to the patient's original arch form.[9,12]

A number of attempts have been made to find an arch form that would universally fit every individual. A variety of mathematical methods have been used to define these arch forms, including geometric curves, such as parabolas[16], ellipses[17], catenary curves[18]and equations, such as, cubic splines[19], polynomial functions[20], conic sections[21], beta function[22] and the Bezier cubic equation.[23] Nonetheless, many studies suggest that adjustment of the archwire forms is obligatory as none of archwire form is universal.[6,9,11]

Many clinicians are inclined to use archwires manufactured by selective famous brands. The objective of this study was to analyse which archwire fits best to the mandibular arch form among different commercially available archwires in Pakistan. In the present study, only mandibular arch was analysed because both mandibular and maxillary arch forms are closely associated with each other, and also in order to achieve stable orthodontic treatment results it is essential to maintain mandibular intercanine width and mandibular incisor labiolingual position.

METHODOLGY

This was a cross-sectional study. Approval was sought from the hospital's ethical committee for the study. Non-probability, purposive sampling technique was used. Sample size was 100 and it was calculated by using the following formula:

$N = z^2pq$

e^2

N: sample size

z: standard value of 1.96 for confidence level set at 95%

p: population variance, 0.53 as determined from a previous study[9]

q: (1-p) 0.47

e: alpha error set at 10%.

In the present study, data was collected from pre-treatment mandibular casts of 230 patients who came to the Orthodontics department of Margalla Institute of Health Sciences, Rawalpindi over a period of 8 months from March 2017 to October 2017.

Inclusion criteria were

- Pre-treatment mandibular casts of the patients with any class of malocclusion.
- Both male and female patients having permanent dentition at least up to 2nd molars.

Exclusion criteria were

- Patients with incisal or cuspal attrition.
- Patients with fractured teeth, hypodontia or hyperdontia.
- Patients having history of previous orthodontic treatment.

Age range of the sample was 12 years to 28 years.

Seven types of prefabricated heavy stainless steel (0.017x0.025 inch SS) archwires from 3 different manufacturers were chosen for analysis (Table 1). Preformed NiTi and SS archwires from a same manufacturer have identical shapes but as NiTi archwires are flexible, they can be displaced during scanning process so we have chosen SS archwires for making archwire templates because of their stiffness.

The archwires were scanned by using a flatbed scanner (HP Scanjet Enterprise 7500) at a resolution of 600 dpi by using image-editing software (version 7.0, Photoshop, Adobe, San Jose, Calif). The images of archwires were then printed on transparency sheet with a 2mm grid to make archwire templates.

Archwire templates were then placed over occlusal surface of mandibular cast of each patient in such a way that archwire midline (marked on template as red line) coincided with mandibular dental midline. Archwire that corresponded to the patient's arch form more closely and touched the maximum number of teeth (incisal edges of incisors and cusp tips of canine, first and second premolars and molars) was termed as best fit. All the data was recorded on proforma.

The statistical analysis was done with SPSS software (version 16.0, SPSS Inc, Chicago, III)). Mean and standard deviation were calculated for age. Frequency and percentages were calculated for distribution of different commercially available archwires as best fit archwire.

RESULTS

Mean age of the sample was 15±1.8 years. Among 100 patients enrolled in the study, 72 were female and 28 were male patients. Table 2 shows frequency and percentage of different commercially available archwires as best fit archwire. Ortho Organizers Oval Arch Form was found best fit in 34% of patients whereas Ortho Organizers Standard Form matched the mandibular arch form more closely in 27% of the

patients. 3M Unitek Ortho Form I (tapered) was found best fit in 15% of the patients. Archwire having lowest frequency (2%) as best fit was 3M Unitek Ortho Form II (square).

DISCUSSION

Arch form is a specific characteristic of individual development due to many small but important changes in its shape with time. Based on evidence from past studies, it is shown that the width of the dental arch undergoes changes with age. The arch width shows rapid increase, more specifically during the mixed dentition stage however these changes are below 1 mm in permanent dentition stage.[4] Therefore, the permanent dental arches were appropriately chosen for our study.

Felton et al[6] performed a study in United States and included mandibular dental casts of 30 untreated normal cases, 30 Class I non-extraction cases, and 30 Class II nonextraction cases. They compared 17 commercially produced archwires. Their results revealed that there is no dominance of one archwire over another and due to great variability in arch form, customization of archwires was deemed necessary in majority cases. This is in contrast to our findings as we found that Ortho Organizers archwires (Oval Arch Form and Standard Form) have higher frequency as best fit archwire and they are more compatible with mandibular arch form of 34% and 27% of the patients respectively.

Oda et al[10] carried out a study in Japan to compare 20 commercially available archwires with mandibular arch form in 30 subjects with normal occlusion. Evidence from their study showed that commercially available arch wires were narrower as compared to the natural width of the dental arches of the Japanese population and, therefore, the archwires need to be expanded by 1-3 mm at the canine level and by 2-5 mm at the molar level. In contrast to this, square form archwire (Ortho Form II) was found least compatible with mandibular arch form (2%) in the present study. This can be attributed to the fact that the sample for their study mainly comprised of Angle class III malocclusion whereas in our study patients were randomly chosen irrespective of their class of malocclusion (Angle class I, II, and III) and Japanese have wider mandibular arches as compared to the other ethnic groups while ovoid[24] and tapered[25] arch forms are more prevalent among Pakistani population.

TABLE 1: THE 7 PREFORMED ARCHWIRES USED IN THE STUDY

Sr No.	Archwire	Manufacturer
1	Ortho Form I (Tapered)	3M Unitek, Monrovia, Calif
2	Ortho Form II (Square)	3M Unitek, Monrovia, Calif
3	Ortho Form III (Ovoid)	3M Unitek, Monrovia, Calif
4	Oval Arch Form	Ortho Organizers, Carlsbad, Calif
5	Standard Form	Ortho Organizers, Carlsbad, Calif
6	Euroform	Ortho Care, Saltaire, UK
7	Standard Form	Ortho Care, Saltaire, UK

TABLE 2: FREQUENCY AND PERCENTAGE OF DIFFERENT COMMERCIALLY AVAILABLE ARCHWIRES AS BEST FIT ARCHWIRE

Best fit mandibular archwire	Frequency	Percentage
3M Unitek Ortho Form I	15	15%
3M Unitek Ortho Form II	2	2%
3M Unitek Ortho Form III	7	7%
Ortho Organizers Oval Arch Form	34	34%
Ortho Organizers Standard Form	27	27%
Ortho Care Euroform	8	8%
Ortho Care Standard Form	7	7%
Total	100	100%

Hedayati and coworkers[26] conducted a study in Iran to compare 12 commercially available archwires with mandibular arch. They concluded that narrow arch wires with a tapered shape (Ortho Form I) are better consistent with the Iranian lower arch. In comparison to their study, we found that in Pakistani population, ovoid shaped archwires (Oval Arch Form) followed by tapered shaped archwires (Ortho organizers Standard Form) fit best to mandibular arch form. This dissimilarity of findings can be because tapered is most prevalent and ovoid is the least prevalent arch form in Iran[26] whereas in Pakistan ovoid is also a common arch from along with tapered form.

A similar study was done by Afzal et al[9] in Karachi, Pakistan. They compared the frequency distribution of the only three archwires (Ortho Form I, Ortho Form II, Ortho Form III) of 3M Unitek. Their study concluded that Ortho Form I and Ortho Form III are more compatible with mandibular arch form in majority of

the subjects. This is in contrast to the present study, according to which Ortho Organizers archwires (Oval Arch Form and Standard Form) are best fit in most of the patients rather than 3M Unitek archwires. In our study Ortho Form I was found best fit in only 15% of the sample whereas Ortho Form III in only 7% of the sample. It might be due to ethnic differences in shape and dimension of arch forms of selected samples. Their sample mainly comprised of Urdu speaking and small proportion of other ethnic groups, such as Punjabi, Sindhi, Pathan and Balochi whereas in our sample majority of the subjects were Punjabi and Pathan.

Therefore it is critically essential that orthodontists first correctly identify the patient's arch form and then select the archwire that fits best to the patient's arch form to avoid undesirable side effects.

CONCLUSIONS

Among different commercially available archwires, Ortho Organizers archwires (Oval Arch Form and Standard Form) were found best fit to the mandibular arch form in majority of the patients.

REFERENCES

1 Bhowmik SG, Hazare PV, Bhowmik H. Correlation of the arch forms of male and female subjects with those of preformed rectangular nickel-titanium archwires. Am J Orthod Dentofacial Orthop. 2012;142(3):364-73.

2 Bayome M, Sameshima GT, Kim Y, Nojima K, Baek SH, Kook YA. Comparison of arch forms between Egyptian and North American white populations. Am J Orthod Dentofacial Orthop. 2011;139(3):e245-52.

3 De La Cruz RA, Sampson P, Little RM, Artun J, Shapiro PA. Long term changes in arch form after orthodontic treatment and retention. Am J Orthod Dentofacial Orthop. 1995;107:518-30

4 Gafni Y, Tzur-Gadassi L, Nojima K, McLaughlin RP, Abed Y, Redlich M. Comparison of arch forms between Israeli and North American white populations. Am J Orthod Dentofacial Orthop. 2011;139(3):339-44.

5 Burke SP, Silveira AM, Goldsmith LJ, Yancey YM, Stewart A, Scarfe WC. A meta-analysis of mandibular inter-canine width in treatment and post retention. Angle Orthod. 1997;68:53-60.

6 Felton MJ, Sinclair PM, Jones DL, Alexander RG. A computerized analysis of the shape and stability of mandibular arch form. Am J Orthod Dentofacial Orthop. 1988;92:478-83.

7 Kahl-Nieke B. Retention and stability considerations for adult patients. Dent Clin North Am. 1996;40:961-94.

8 Lyotard N, Hans M, Nelson S, Valiathan M. Short-term post orthodontic changes in the absence of retention. Angle Orthod. 2010;80:1045-50.

9 Afzal A, Shahbaz S, Shah R. Best fit prefabricated archwire. J Surg Pak. 2006;11(4):154-8.

10 Oda S, Arai K, Nakahara R. Commercially available archwire forms compared with normal dental arch forms in a Japanese population Am J Orthod Dentofacial Orthop. 2010;137(4):520-7.

11 McNamara C, Drage KJ, Sandy JR, Ireland AJ. An evaluation of clinicians' choices when selecting archwires. Eur J Orthod. 2010;32(1):54-9.

12 Lombardo L, Fattori L, Molinari C, Mirabella D, Siciliani G. Dental and alveolar arch forms in a Caucasian population compared with commercially available archwires. Int Orthod. 2013;11(4):389-421.

13 Lee RT. Arch width and form: a review. Am J Orthod Dentofacial Orthop. 1999;115(3):305–13.

14 Bishara SE, Chadra JM, Potter RE. Stability of intercanine width, overbite and overjet correction. Am J Orthod. 1973;63(6):588–95.

15 Nojima K, McLaughlin RP, Isshiki Y, Sinclair PM. A comparative study of Caucasian and

16 Japanese mandibular clinical arch forms. Angle Orthod. 2001;71(3):195-200.

17 Ferrario VF, Sforza C, Miani A Jr, Tartaglia G. Mathematical definition of the shape of dental arches in human permanent healthy dentitions. Eur J Orthod. 1994;16:287-94.

18 Brader AC. Dental arch form related to intraoral forces: PR=C. Am J Orthod. 1972;61:541-61.

19 Pepe SH: Polynomial and catenary curve fits to human dental arches. J Dent Res. 1975;54:1124-32.

20 BeGole EA, Lyew RC. A new method for analyzing change in dental arch form. Am J Orthod Dentofacial Orthop. 1998;113:394-401.

21 Noroozi H, Nik TH, Saeeda R. The dental arch form revisited. Angle Orthod. 2001;71:386-89.

22 De La Cruz AR, Sampson P, Little RM, Artun J, Shapiro PA. Long-term changes in arch form after orthodontic treatment and retention. Am J Orthod Dentofacial Orthop. 1995;107:518-30.

23 Noroozi H. Re: The form of human arch. Angle Orthod. 2000;70:271-75.

24 The evaluation of dental arch forms of subjects with normal occlusion and maxillary constriction using computerized bezier arch curve. [thesis]. Ankara: Hacettepe University; 1998.

25 Saleem T, Shafique A. Mandibular arch form analyses: a comparison between results of two different methods. Pak Oral Dental J. 2012;32:556-60.

26 Tajik I, Mushtaq N, Khan M. Arch forms among different angle classifications, A study. Pak Oral Dental J. 2011;31:92-5.

27 Hedayati Z,Fakhri F, Moshkel V. Comparison of Commercially Available Arch Wires with Normal Dental Arch in a Group of Iranian Population. J Dent (Shiraz). 2015;16:106–112.

CONTRIBUTIONS BY AUTHORS

1 Amjad Mahmood:	Suggested the research topic, supervised the research, reviewed the article and done the proof reading.
2 Nazish Amjad:	Has done the literature review, collected all the data, full write up of the article done.
3 Rai Tariq:	Done the statistics of the article, analyzed the results, helped in write up.
4 Rozina Nazir:	Checked the plagiarism and done the proof reading.